Effect of indoor air quality on the incidence of ARI in infants in two slums of Delhi

Introduction

Acute respiratory infection (ARI) is one of the commonest causes of morbidity and mortality in children (Guidelines for management of acute respiratory infections in children, National Child Survival and Safe Motherhood Program). More than four million children under the age of five years die of pneumonia annually worldwide. Incidence and severity of pneumonia is considerably higher in developing countries. The annual incidence rate of pneumonia in children 0-4 years of age according to WHO is 7 to 18 (or higher) per 100 in developing countries and 3-4 per 100 children in developed countries. In India, it is estimated that 15-20% of all children under five years of age suffer from pneumonia every year. Of these, ARI accounts for 15-30% childhood deaths with a mortality ranging from 3.2 to 13.8 per 1000 children. Case fatality rate in hospitals is up to about 10%. Approximately 20-25% of deaths from ARI occur in the young infants (less than two months of age) and nearly 50-60% occur in infants. Comparatively, very few deaths from ARI occur in children between 1-4 years of age (Guidelines for Management of ARI in National CSSM Program).

Various studies have shown a close relationship between the incidence of ARI and age (Selwyn, 1990; Berman et al, 1985; Load et al, 1968; Glezen et al, 1973). A community based epidemiologic study conducted in Beijing showed that highest incidence of ARI occurred in children below one year of age (4.2 episodes per child per year in infants as compared to 2.1 episodes per child per year among children 4-5 years old (Pio, 1986). The pattern of age specific rates of acute lower respiratory infection (ALRI) have a striking stair step pattern of decreasing incidence rates with increasing years of age in all studies except that of the birth cohort of Colombia (Selwyn, 1990).

Host, environmental and socio-cultural related variables may act independently or in concert with other variables to influence the incidence and severity of ALRI. These risk factors include low socio-economic status, low birth weight, large family size, overcrowding, poor sanitation, malnutrition, lack of immunization, vitamin A deficiency, lack of breast feeding, parental smoking and exposure to pollution. While low socio-economic status is associated with ARI morbidity, it is important to understand the relative contribution of various other factors mentioned earlier that provide the transmission of respiratory pathogens and increase the size of infecting inoculum. Settings such as slums, with inadequate water supplies and sanitation system predispose to poor personal hygiene can further enhance transmission. These risk factors also predispose children to frequent and recurrent infections that impair tissue recovery and lead to more severe disease. Use o bio mass fuel is an important cause of indoor pollution. Wood, agricultural waste or manure are used for cooking and heating by 30% of urban households and 90% rural households in the developing world. Most of the cooking is done indoors in unvented rooms.

Bio mass smoke is one of the predisposing factors in ARI (Pandey et al, 1989; Morris et al, 1990; Honicky et al, 1985) but its importance in relation to other risk factors in young infants is not clearly established (Norboo et al, 1991). Moreover, there are few studies which quantified the effect of environmental factors such as indoor air pollution as a risk factors for ARI in developing countries. The highest exposures are probably experienced by women, infants and young children. Measured levels of air pollution in these houses in developing countries greatly exceed indoor and outdoor concentration found in developed countries (Smith et al, 1987). Exposure to pollution from wood burning stoves for indoor heating in developed countries has also been associated with more severe respiratory symptoms and mortality (Honicky et al, 1985; Johnson et al, 1992). In England and Scotland, prevalence of ARI was significantly associated with levels of atmospheric smoke (Meliga et al, 1981).

Over the past few years better medical care in developed countries has reduced the case fatality rate from pneumonia, but the substantial fall in the incidence of pneumonia recorded over the same period must largely be due to improved living conditions. However, it is not known as to which environmental factors contributed most to this fall. Improved indoor air quality and reduced crowding are likely factors. Although immunization and case management are partly effective in ARI, it seems clear that long term solutions will depend on the control of risk factors. Such control e.g., led to striking decrease in moderate and severe ARI in the developed countries long before effective case management became available. Widespread case management would be expensive and not an answer in the long term, since mild ARI can progress through moderate to severe phases and death often in only 2-3 days (Pandey et al, 1989). Therefore, if risk factors predisposing to more severe disease after initial infection can be identified and prevented, much of the mortality and morbidity burden due to ARI can possibly be prevented in developing countries also.

For effective management and control of ARI in the community, data on incidence of ARI and its causation need to be generated. Although some data on ARI is available, most information has been from hospitals and outpatient clinics and has not been community based. Looking at the magnitude of the problem in the context of the child survival and the fact that highest exposures are experienced by infants and this group being most vulnerable (with highest mortality), present community based preliminary study was undertaken.

Aims and objectives of present study were:

- To find out the incidence of ALRI in peak winter season in two slums of Delhi and to assess the magnitude of the problem.
- To find out if there is any relationship between indoor pollution and ARI in children below one year of age, as they are considered to be the target population for ARI control, in addition to identifying the risk factors responsible for increasing the severity of ALRI.

Review of literature

Magnitude of the problem

ARI is one of the commonest causes of morbidity and mortality in children. The incidence figures of ARI are almost same in developed and developing countries. In rural areas, the annual incidence of respiratory episodes per child is much lower than in towns, ranging from 1 to 3 as shown by studies from Ethiopia and Guatemala (Pio et al, 1983).

Although the overall incidence of ARI is similar in urban areas of developing and developed countries, there are large differences in the relative frequency and severity of ALRI, in particular pneumonia. It has been estimated that about 15 million children die annually. Of these 95% occur in socially and economically deprived countries, accounting for 30% of all deaths in childhood (Gwatkin, 1980). Pneumonia un associated with measles causes 70% of all deaths, post measles pneumonia 15%, pertussis 10% and bronchiolitis or croup 5% (WHO, 1983). In India, ARI accounts for 15-30% childhood deaths (Guidelines for Management of ARI, National CSSM Program).

Although some data on morbidity and mortality due to ARI is available. Most information has been from hospitals and patient clinics. However, such studies cannot provide information about the total burden of ARI and are not representative of severe ARI in a community. Furthermore, detailed study of the factors that lead to increased risk of ARI and of progression from mild to severe cases are difficult to conduct (WHO, 1982). Population based studies allow a more comprehensive description of the natural history, morbidity and mortality of ALRI in the community and helps in identifying children at risk.

Selwyn reviewed studies on epidemiology of ARI among children 0-59 month old from several developing countries. Incidence rates from six of the community based studies ranged from 12.7 to 16.8 new episodes of ARI per 100 child weeks at risk, the rates of acute lower respiratory infection (ALRI) ranged from 0.2 to 3.4 new episodes per

100 child weeks at risk. The incidence rates for ARI were highest in younger children. Comparison is difficult to accomplish from these studies because of different design and definition of an episode of ARI. The number of episodes of ARI (whether URI or LRI) depends on the methods used and definition of an episode. List of signs designated by BOSTID (Board on Science and Technology for International Development) for URI (upper respiratory infection) were - at least one of the following: sore throat, cough, purulent nasal discharge or earache/discharge and for LRI were one of the following: respiratory rate (RR) > 50/minute, rales, stridor, wheezing, convulsions or chest indrawing.

Berman et al (1985) used simpler and broader diagnostic criteria: croup was diagnosed by a hoarse brassy cough and inspiratory stridor with or without drooling, tracheobronchitis by cough and rhonchi, bronchiolitis by inspiratory and/or expiratory wheezing without radiographic evidence of consolidation, pneumonia by vales and radiologic evidence of consolidation. Tupasi et al (1988) had diagnosed ALRI on following clinical findings: cough associated with breathing difficulty manifested by tachypnoea, chest indrawing, cyanosis or chest crepitation and radiologic findings while in a later study, they simplified the diagnostic criteria of ALRI to the presence of cough of less than 21 days duration and respiratory rate (RR) of more than 50 per minute or chest in drawing with or without cyanosis (Tupasi et al, 1990).

Cough was not an essential symptom for diagnosis of ALRI where ALRI was defined by the presence of two or more of the following signs and symptoms: tachypnoea, cough, rales, chest indrawing, wheezing and stridor (Weissenbacher et al, 1990). Ghafoor et al (1990) defined ALRI by at least one of the following: tachypnoea (RR > 50 per minute), chest in drawing, stridor, cyanosis, wheezing or rales upon auscultation.

In Nairobi, Kenya 250 families with 470 children less than five years of age were contacted every eight days by field workers during a three year study period. The yearly incidence of ARI decreased from 5.2 to 3.4 during the study and < 5% of these infections involved ALRI. Fifteen children died during the study period possibly because of respiratory infections. This study emphasized the importance of determining risk factors responsible for high morbidity and mortality in children with ARI. Risk factors exhibited different patterns of association with ARI in different studies. These risk factors included mother's age, education, nutritional status, crowding, smoking, etc. The rates of ARI were higher during the colder months (Wafula et al, 1992).

In Guatemala pre-school children incidence of 14 per 100 child weeks or 7.2 episodes per child per year and total of 3646 episodes were detected in 26, 329 child weeks at risk. Auxiliary nurses visited the homes of the participants every two weeks to enquire about ARI and follow the recommendations made by Pan American Health Organization. ALRI was more common among younger infants 0-5 months old with nutritional status having no apparent effect. Parental formal education and crowding in households were found to be directly related to the incidence of ALRI (Cruz et al, 1990).

In an other longitudinal study of 151 children under five years of age in West Africa 6.2 attacks of ARI during the rainy season and 7.2 during the dry season were detected by weekly interviews with the help of field workers. Risk factors for ARI were malnutrition and a high birth rank. At the field dispensary, ARI accounted for 41% of the visits, LRI accounted for 24%, similar to the proportion of LRI among illnesses found during the systemic examination (Lang et al, 1986).

In a study conducted in Andhra Pradesh, India, incidence of ARI was more (19.23%) in the 1-4 year age group than in infants (14.25%) (Patnaik et al, 1991). A similar pattern was observed earlier in rural Haryana where it was found that the ARI incidence was minimum during infancy increasing gradually with age upto 3 years and not consistently thereafter (Kumar et al, 1978). However, in urban Delhi, an opposite picture was observed where the incidence of ARI was 81 per 1000 children during the first year of life and then decreased to 68, 67, 56, 31 per 1000 during subsequent four years (Datta et al, 1969).

In an other retrospective study in Rajasthan, India, the ARI incidence was reported to be 33 episodes per 100 children under five during their fortnightly visits. Mothers in higher socio-economic strata reported higher incidence of ARI for their children due to more accurate recall. Majority of ARI cases (76%) were found to be of mild degree. Twenty six percent of deaths in under five during the previous year were reported to be related to ARI (Madhav et al, 1990).

Hospital based study conducted in 1992 included children aged one month to eleven years with pneumonia diagnosed on the basis of clinical findings and radiological features of consolidation. However, cases of bronchopneumonia were excluded from the study. Logistic regression analysis indicated that age less than six months, presence of associated illness, malnutrition grade III/IV and associated congenital anomalies as significant risk factors (Deivanayagam, et al, 1992).

Aetiology of acute lower respiratory tract infections

Viral and bacterial agents are responsible for most cases of ARI. Viral agents cause the majority of ARI, but only a small percentage of these infections result in severe or fatal disease. Most viral infections are mild in nature, self limiting illness of the upper respiratory tract (AURI). Bacterial agents cause such as acute otitis-media, pharyngitis, and pneumonia. While bacterial pneumonia is less common than viral, but death is far greater with it. The estimated case fatality rate for bacterial pneumonia due to *Streptococcus pneumoniae* and *Haemophilus influenza* is 50 times higher than the case fatality rate for infection due to *Respiratory syncytial virus* (RSV) or *Parainfluenza* virus, yet the estimated number of deaths due to bacterial pneumonia is only 2.7 times higher than the number due to viral infections (Berman, 1991).

A high incidence of mixed viral and bacterial infection has been reported in developing countries (Guidelines for Management of ARI in Children, National CSSM Program). In Papua New Guinea, two thirds of documented viral infections occurred concurrently with a bacterial infection as diagnosed by isolation of the pathogen from lung or blood (Shann et al, 1984). In Pakistan, 26% of the children infected with RSV also had bacterial infection with *Hemophilus influenza* or *Streptococcus pneumoniae* (Ghafoor et al, 1990). Fifty four percent of infection with *Hemophilus* and 47% of infection with *Streptococcus pneumoniae* were associated with viral infection. However, limited information is available on the inter-relationship between viral and bacterial infection. Several types of relationships are possible: (i) viral and bacterial infections of the lower respiratory tract are common but not inter-related, (ii) viral infections damage the respiratory tract and thus predispose to secondary bacterial infections and more severe disease, (iii) bacterial infection predispose to viral disease, and (iv) mixed infections, regardless of the relationship between primary and secondary pathogens, have additive effects that result in severe disease (Berman, 1991).

Presently, culture of lung aspirate provides reliable method for a bacterial diagnosis. The clinical use of this method is limited by its invasiveness and high false negative results specially if aspiration is not done properly (Shann, 1986). Data on blood culture isolates in ARI in early infancy (< 2 months of age) from developing countries is inadequate (Ghafoor et al, 1990; Borrero et al, 1990; Berman et al, 1978). Since a very high proportion of children with pneumonia have a bacterial aetiology and the difficultly in determining its aetiology, it is suggested that all children diagnosed to have pneumonia should receive empirical antibiotic treatment (Guidelines for National CSSM Program). The antibiotic selected for initial treatment should be effective against at least two of the commonest bacterial isolates, i.e., *Streptococcus pneumoniae* and *Hemophilus influenza*. . The aetiology of pneumonia in infants less than two months is less well described, however, both gram positive cocci and gram negative enteric bacilli are implicated.

The National Program for Control of ARI (NARICOP) recommended cotrimoxazole for the treatment of pneumonia for the following reasons:

- Very high proportion of children with pneumonia have a bacterial infection, in addition, mixed infections with viral agents are also common.
- Studies have shown that *Streptococcus Pneumonia* and *Hemophilus influenza* are the two commonest bacterial causes of pneumonia in children older than two months and are generally sensitive to cotrimoxazole.

- Cure rates and time taken for recovery are similar to ampicillin, amoxycillin and procaine penicillin.
- Therapy with cotrimoxazole is cheap and convenient as it can be administered in two daily doses.
- Serious side effects related to Cotrimoxazole are rare in children (Guidelines for National CSSM, 1990).

Risk factors influencing incidence and severity of ARI

Factors that increase the incidence of ALRI and mortality due to ALRI include low socio-economic status, low birth weight, family size, crowding, poor sanitation, malnutrition, lack of immunization, vitamin A deficiency, lack of breast feeding, parental smoking and exposure to pollution.

While low socio-economic status is associated with ARI morbidity, it is important to understand the relative contribution of related factors such as large family size and overcrowding, poor sanitation, malnutrition, lack of immunization, increasing birth order and environmental factors that provide the transmission of respiratory pathogens and increase the size of the infecting inoculum. Settings with inadequate water supply and sanitation system lead to poor personal hygiene and can further enhance transmission. These risk factors predispose children to frequent and recurrent infections that impair tissue recovery and lead to more severe diseases.

The impact of crowding on ALRI has been studied by various workers. In Philippines was associated with a 1.24 fold increase in total incidence of ARI was observed (Tupasi et al, 1988). In several BOSTID studies there was a trend toward higher rates of ARI (Ruutu et al, 1990). However, differences in definition of crowding and population characteristics (especially age) limit comparison between studies.

A prospective case management intervention study in Haryana, India, compared the incidence and severity of respiratory infections and the case fatality rates or ALRI in low birth weight and normal infants (Datta et al, 1987). The incidence of AURI and ALRI were similar. However, the case fatality rate among low birth weight infants (24.6%) was almost eight times higher than that of normal infants (3.2%). The ARI related mortality among low birth weight infants living in Papua New Guinea is reported to be four times higher than that for normal infants (Lehmann et al, 1988). Young age amongst others viz. lack of immunization, delayed weaning and overcrowding was significant risk factor for severe pneumonia (Shan et al, 1994).

Malnutrition produces multiple deleterious effects, including alteration in immune and non immune host defenses, respiratory muscle weakness, diminished energy stores and impairment in the recovery of normal pulmonary tissue from inflammation. A hospital based study in the Philippines compared the frequency of ARI, complications and case fatality rate among children with malnutrition and normal nutrition using weight for age classification. The case fatality rate among children with severe malnutrition was 27 times higher (14.5%) than that among normal children (Tupasi et al, 1988). Similarly, a seven-fold increase in mortality was noted in children hospitalized with pneumonia in Cali, Columbia, (Escobar et al, 1976). Malnourished children with severe ALRI also had two or three times higher mortality risk than that of healthy children (Tupasi et al, 1990). The combined analysis of Board on Science and Technology for International Development (BOSTID) studies revealed a stronger association between lower percentiles for age measures and higher rates of ARI and ALRI in older children than in children below 18 months (Selwyn, 1990). Vitamin A deficient xerophthalmic children living in Indonesia were noted to have four times the mortality rate of children without xerophthalmia (Sommer et al, 1984).

Breast feeding may confer passive immunity by delivering antibody and immunocompetent cells to the surface of upper respiratory tract. In India, 35 breast fed infants and 35 infants fed with cow's milk were monitored weekly at home for 12 months by a trained auxiliary midwife. Breast fed infants experienced 57 episodes of ARI and 21 episodes of purulent ear discharge as compared with 109 episodes of ARI and 52 of otitis media in infants who were not breast fed (Chandra et al, 1979). Breast fed infants in London have also been shown to have fewer episodes of ALRI than bottle fed infants (Watkins et al, 1979). However, confounding variables such as living conditions, family size, exposure to pollution and allergic disorders limit the interpretation of data in these studies.

Air pollution has also been identified as a factor particularly environmental tobacco smoke (ETS) for ARI in young children. In many developing countries, in addition to an increasing amount of tobacco smoke, many homes (30% of urban households and 90% rural households) contain high levels of smoke from combustion of bio fuels such as wood, agricultural waste or manure for cooking or heating usually without a chimney and with poor ventilation (Koning, 1985).

However, there have been few studies that quantify the effect of environmental factors such as air pollution as a risk factor of ARI in developing countries. Most of the cooking is done indoors using invented stoves. The highest exposures are probably experienced by women, infants and young children. Measured levels of air pollution in these houses in developing countries greatly exceed indoor and outdoor concentration found in developed countries (Smith, 1987). An epidemiological study on chronic bronchitis among adults has shown a significant association between the prevalence of chronic bronchitis and exposure to domestic smoke pollution (Pandey et al, 1984).

The results of a semi-quantitative epidemiologic study in Nepal showed a direct relation between reported hours per day spent near the stove by infants and children aged under two years of age and episodes of life threatening ARI (Pandey et al, 1987).

A matched case control study conducted in Argentina showed that the presence of outdoor contaminants especially chimney smoke was a significant risk factor for indoor children with ALRI (Cerqueiro et al, 1990).

In less developed countries, the relation between domestic air pollution and chronic obstructive airways disease has been documented in adults (Norboo et al, 1991; Pandey et al, 1984) but the link with childhood respiratory disease has not been shown convincingly.

There are several mechanisms by which the smoke from bio mass fuels might contribute to ARI in children. Toxic substances in the smoke may alter the integrity of the epithelia lining the respiratory tract, disrupts mucociliary function, may make pulmonary tissue more susceptible to damage by inflammatory response and may compromise the pulmonary recovery process and thereby increasing the susceptibility to lower respiratory tract infections. These substances may also cause bronchial hypersensitivity in young children leading to recurrent wheezing.

It is important to consider secondary effects of smoke pollution, such as increased risk of intrauterine growth retardation and the delivery of a low birth weight infants, which are incurred by exposure during pregnancy (Berman, 1991). Some ETS studies have found a dose response relation between the number of cigarettes smoked in the home and respiratory symptoms in children. Ferris et al (1985) for example, found a risk factor of about two for several symptoms at household levels of 50 cigarettes per day. Fergusson et al (1981) reported a linear dose response relation of three ARI episodes per five cigarettes daily per 100 child years. Several other studies have also documented an increase in episodes of ARI among children exposed to passive smoking in developed countries (Pedreira et al, 1985; Lepage et al, 1981; Schulte-Hobein et al, 1992).

Pandey et al (1989), in a preliminary study, have shown that episodes of moderate and severe ARI increased with increase in the level of exposure to domestic smoke pollution. Several studies suggest that wood burning stove use may be a significant etiologic factor in recurrence of symptoms of respiratory illness in young children (Morris et al, 1990; Pandey et al, 1989; Honicky et al, 1985; Johnson et al, 1992). Furthermore, findings of Johnson et al (1992) suggest an adverse association between outcome of ARI and domestic exposure to wood smoke i.e., higher mortality in wood users, in Nigeria.

In England and Scotland, prevalence of ARI was significantly associated with higher levels of atmospheric smoke (Meliga et al, 1981). However, results of Shah et al (1994) did not depict an increased risk from indoor contaminants viz. smoke from cigarettes or bio fuels, for greater severity of pneumonia.

Materials and methods

The study design was prospective cohort with respect to time frame for data collection on symptoms that occurred in winter season (November 1, 1994 - February 28, 1995). The study area comprised of two urban slums namely Kathputly Colony and Kusumpur Pahari which are situated at west and south edge of Delhi respectively. A census of the population was done at the beginning of the study, and 642 infants below the age of one year were selected at random from the population for the purpose of this study. For details of sample selection and study design see section 1.1. These children were further divided into two groups depending upon the fuel (kerosene/wood) used for cooking in the family. Two doctors and 12 health workers with previous experience of working in the community were selected for the purpose of collecting data and management of cases. All of them were imparted prior training. The objectives of the four days training program were to impart:

- Knowledge about role of ARI in childhood morbidity and mortality.
- Anatomical considerations and clinical presentation of various conditions included under ARI which included:
  - Acute upper respiratory infection (AURI) - simple cold, otitis media, pharyngitis.
  - Acute lower respiratory infection (ALRI) - epiglottitis, laryngitis, bronchitis, bronchiolitis and pneumonia.
- Skill to count the respiratory rate to be able to assess the severity of disease by identifying presence of subcostal recession, cyanosis, stridor, etc. This was achieved by showing them few cases in the paediatric emergency ward of Lok Nayak Jai Prakash Narain Hospital, New Delhi.

At the end of training, these health workers were able to differentiate pneumonia from no pneumonia using National Acute Respiratory Infection Control Program (NARICOP) and WHO criteria. Since, these criteria are management oriented and suitable for operational purposes at peripheral health case level.

Lastly they were trained to carry out other procedures of the study protocol including filling up the questionnaire.

The study group consisted of 642 infants in both slums, 316 in Kathputly Colony and 326 in Kusumpur Pahari. Each health worker was assigned 55-56 infants and required to visit them twice a week to collect information on ARI. Parents of all infants were interviewed using a structured questionnaire at the beginning of the study only (Annexure 1). The questions were self explanatory and required a yes or no or number answer. Daily charts were filled which showed number of absentees and number of ALRI cases per day along with duration of illness (Annexure 3). Respondents first answers were used in the analysis of the data. In addition to demographic data, socio-economic status, detailed history to elicit possible risk factors like immunization, nutritional status and past history of any episode of ALRI (pneumonia, bronchiolitis and wheezing) was recorded. Age was noted as told by mother in completed weeks. All children were weighed accurately every month. However, weight recorded at first encounter was considered for analysis of nutritional status. Nutritional status was graded utilizing Gomez classification with reference to NCHS (National Center for Health Statistics) standards for weight for age (Normal: > 90%, Mild: 90-76%, Moderate: 75-60%, Severe: < 60%). A detailed proforma was filled to record signs and symptoms of each episode of ALRI and diagnosis made by the health worker and the doctor (Annexure 2).

Case children were those with a diagnosis of pneumonia, bronchiolitis, croup or bronchial asthma. Children with even one episode of ALRI during the course of study diagnosed on the basis of criteria used in NARICOP and WHO were taken as cases. ARI was defined clinically as the presence of cough of less than four weeks duration with one or more of the following symptoms: fever, rapid breathing, noisy breathing, running nose, sore throat and otorrhoea (for defining acute otitis media the duration was reduced to two weeks). WHO clinical classification for ARI was used for defining cases and control:

- "No pneumonia" when a patient had cough but neither chest in drawing nor fast breathing.
- "Pneumonia" when a patient had fast breathing (60 breaths/minute or more in children 0-2 months; 50 breaths/minute or more in children aged 2-12 months; and 40 breaths/minute or more in children aged 13-60 months) as well but no chest retraction.
- "Severe pneumonia" when a patient had fast breathing and chest retraction.
- "Very severe illness" when in addition to severe pneumonia the child had one or more of the following: inability to drink, convulsions, abnormal sleepiness or difficulty in waking, stridor when calm, wheezing and severe under-nutrition.
- All infants below the age of two months with features suggestive of pneumonia or systemic infections were presumed to be very severely ill.

To be included as a case of bronchiolitis required the following: fever, respiratory rate as defined for pneumonia, wheeze with or without respiratory distress on clinical examination. Laryngotracheo-bronchitis or croup was defined when infants presented with brassy cough, inspiratory stridor, hoarseness and/or respiratory distress. Diagnosis of bronchial asthma was made if infants suffered from more than two episodes of wheezing in the year.

In order to record different episodes of ALRI the following, working definition was adopted if a child suffering from ALRI was reported to be completely free of signs and symptoms of ALRI for at least seven days and then if contracted another ALRI attack, it was considered a new/fresh episode of ALRI.

Health workers collected data on environmental factors such as source of heat and cooking and exposure to other potential sources of indoor pollutants such as smoking by family members, cooking practices and fuel used in the house. Other environmental factors reported included recent (number of rooms and other home characteristics e.g. floor, running water supply, etc. A team from TERI consisting of research workers and field workers carried out the assessment of carbon monoxide levels, respiratory suspended particulate levels inside the house in selected houses by using various equipments as described in Chapter 6 of the exposure report.

During their visit to the households, health workers picked up cases who had symptoms suggestive of ALRI. They counted the respiratory rate in all such children and looked for any feature suggestive of severe pneumonia or very severe illness. A detailed proforma was filled (Annexure 2). All children with fast breathing with or without features of severe pneumonia or very severe illness were taken to the study physician to get the diagnosis confirmed. Children with doubtful ALRI were also taken to the doctor for his opinion. The doctor confirmed the diagnosis by counting the respiratory rate himself and did a detailed clinical examination to assign these children with ALRI, a specific diagnosis such as pneumonia, bronchiolitis, croup or bronchial asthma. They also classified the episode as pneumonia, severe pneumonia and very severe illness.

For the mild cases of URI, investigators gave palliative treatment or home remedies but no antibiotics. All infants in the age group two months to five years diagnosed as ALRI were treated with tablet or syrup cotrimoxazole (Trimethoprim 8 mg/kg/d + Sulphamethoxazole 40 mg/kg/d) 12-hourly or which included Ampicillin (50 mg/kg/d) in three divided doses, cephelexin 30 mg/kg/d or erythromycin orally for 5-7 days as recommended by NARICOP as the initial antibiotic for ambulatory treatment. Fever was treated with paracetamol 30 mg/kg/d. If the child was less than one month, cotrimoxazole syrup (40 mg trimethoprim/5 ml) 1.5 ml 12-hourly or paediatric tablet (20 mg trimethoprim per tablet) 1/2 tablet 12-hourly was prescribed. For those aged 1-2 months, gave one tablet twice daily or 2.5 ml twice daily as prescribed in addition to supportive care necessary for young infants.

Young infants less than two months of age and children with severe pneumonia and very severe illness were referred to hospital since they required parenteral therapy with benzyl penicillin or ampicillin or chloramphenicol and should be treated at a place with provisions of oxygen. Those parents reluctant to take their child to hospital or where hospitalization for parenteral therapy was not possible, oral antibiotics (cotrimoxazole) was administered at home. All drugs were bought by generic names and supplied to the mother free of cost.

Indicators of good response to antibiotics were: subsiding fever if present initially, lesser chest in drawing, decreasing respiratory rate, and child began to drink and eat better.

All cases were reassessed after 48 hours but earlier if: breathing became difficult, child was not able to drink, and child became more sick.

Children who were absent from the study area for more than four consecutive weeks were not included for the final analysis. Proforma not containing relevant details were also omitted from the final analysis.

Analysis of data

The occurrence of symptoms of ALRI in infants in the wood burning stove group was compared with that of infants in the kerosene burning stove group to determine whether there was any relationship between indoor pollution and ALRI.

Statistical analysis of the association between ARI and potential risk factors were performed with use of the stratified analysis technique. Additional software used for management and analysis of the data included dBASE III Plus and Statistical Package for Social Sciences Software (SPSS/PC+). Chi square and Fisher exact test were used as tests of significance.

Results and observations

A total of 642 children were included in the study of which 9 were excluded because their families were using both wood and kerosene stoves. Hence, 633 children were finally included for analysis. There were 317 children in Kusumpur Pahari, of which, 142 belonged to the wood user families and 175 to kerosene users. There were 64 controls and 78 cases of ALRI amongst wood users and 81 controls and 94 cases amongst kerosene users. The age and sex distribution of cases and controls in wood and kerosene users is given in Table 1. The groups were age and sex matched and there was no difference between the two groups.

Of 316 children in Kathputly Colony, 174 belonged to wood users and 142 to kerosene users. There were 33 cases of ALRI in wood users and 45 cases in kerosene users (Table 2). The age and sex distribution of controls and cases were comparable in this area as well.

Demographic data amongst wood user families and kerosene users in Kusumpur Pahari were compared (Table 3). When level of parental education was analyzed it was found that about half (49.3%) of the fathers of children from wood user families were illiterate but surprisingly out of literate 26.1% had passed middle class and 18.3% had qualified up to secondary level. Percentage of secondary level and secondary level educated among kerosene user families were even higher, i.e., 36% and 23.4% respectively. On the contrary, majority of mothers were illiterate, 88% amongst wood users and 74.3% in kerosene user families. However, the difference between level of education of fathers and mothers when compared between cases and controls was not significant in both wood users and kerosene users. Majority of fathers were self employed and mothers were housewives in both wood and kerosene users families. However, the number of self employed was less in kerosene users and difference was statistically significant. Family size in both kerosene users and wood users were found to be large. Almost half of the families had more than two children. But in majority of the families gap between index child and older sibling appears to be more than two years (Table 3).

Table 4 shows the demographic data of families in Kathputly Colony. It is evident that more than 60% of the fathers were illiterate and about 90% mothers were illiterate. There was no statistically significant difference between cases and control of wood users and kerosene users as far as fathers' education was concerned. But there were higher number of illiterate mothers amongst controls (97.9%) of wood users as compared to kerosene users (90.9%) and difference was statistically significant. Majority of the fathers were self employed and mothers were housewives. The family size in Kathputly Colony in more than 60% of the families was more than four in both wood users and kerosene users. The comparison of family size between cases and controls in both the groups shows no difference. In both cases and controls, the age gap between index child and elder sibling appeared to be more than two years in wood users as well as kerosene user families.

Table 5 shows comparison of demographic data of wood users and kerosene users in both Kusumpur Pahari and Kathputly Colony. Total number of cases in Kusumpur Pahari were 172 while in Kathputly Colony it was 78. There were 54.9% cases among wood users and 53.7% cases in kerosene users in Kusumpur Pahari. There was no statistically significant difference in number of cases between two groups but in Kathputly Colony there were 33 (19%) cases in wood users and 45 (31.7%) cases in kerosene users and this difference was statistically significant.

When level of education was compared in mothers and fathers of children in wood user in Kusumpur Pahari, it was found that difference in the level of education in fathers was not statistically significant while in mothers there were more literate (primary level) amongst kerosene users (35.7%) as compared to 12.1% in wood users ($P < 0$).

In Kathputly Colony, there were more literate females in kerosene users. The number of males who were working on daily wages was higher in both the groups in both areas but when compared with self employed the difference was statistically significant in Kathputly Colony.

Table 6 shows the nutritional status and immunization status in both the groups at Kusumpur Pahari. The percentage of children with normal nutritional status was 35% in wood users and 40% in kerosene users, others were malnourished. No statistically significant difference was observed when level of malnutrition was compared between controls and cases.

The number of children who were either partially immunized or un immunized was 71.9% in controls and 74.4% in cases in wood users. Whereas in kerosene users 64.2% in controls and 61.7% in cases were either partially immunized or un immunized respectively.In Kusumpur Pahari the difference in immunization status between controls and cases in both the groups was statistically insignificant. Almost 50% of the eligible children in both controls and cases were not immunized against measles in both the groups.

Almost a similar number of children were found to be malnourished in kathputly Colony as well (Table 7) and the difference between controls and cases was statistically insignificant in both the groups. Immunization status too was comparable in controls and cases in both wood users and kerosene users. More than 70% children who were eligible for measles were un immunized in controls and cases of both the groups.

Table 8 shows the comparison of nutritional and immunization status between wood users and kerosene users in both study areas. In Kusumpur Pahari, number of severely malnourished children were significantly more (25.8%) as compared to kerosene users (10.7%). Similarly, in Kathputly Colony, there were more un immunized children among wood users. Measles immunization status was comparable in both groups in these study areas.

Table 9 gives the distribution of children suffering from ALRI according to the number of episodes they suffered during the study period. At Kusumpur Pahari 54% of the children had suffered from LRTI during the study period, 40% had one episode and 12.6% had two episodes. Almost a similar distribution was observed in kerosene users in Kusumpur Pahari. There were three children with three episodes in wood users while there was only one such case in kerosene users. The number of episodes at Kathputly Colony was much less 18.9% in wood users nd 31% in kerosene users and children with more than one episode were also less comparatively.

The total number of episodes observed in wood users at Kusumpur Pahari was 102 and in kerosene users it was 116 while only 40 and 59 were observed in the respective groups at Kathputly Colony.

All the children who were brought to the doctor with an ALRI were examined and a specific clinical diagnosis was made. The distribution of these clinical diagnosis is given in Table 10. Pneumonia was the commonest ailment in all groups at both the study areas. However, the number of cases with bronchiolitis reported from Kathputly Colony (22.5% in wood users and 27.1% in kerosene users) were more than reported from Kusumpur Pahari (13.7% in wood users and 12.1% in kerosene users). There was only one case of croup reported from Kusumpur Pahari amongst wood users. The only other significant diagnosis that got clubbed with ALRI was bronchial asthma, who were diagnosed by the health workers by WHO criteria as ALRI. There was only one case of respiratory malformations (Laryngo-tracheomalacia) and few cases of bronchial asthma which were included in the diagnosis of ALRI due to fast breathing. Hence, there was a strong concurrence of diagnosis made by health worker and that made by the doctor.

Severity of illness was defined by the health workers based on WHO criteria. Depending upon the information available in the proforma children were diagnosed as pneumonia, severe pneumonia or severe illness. In Kusumpur Pahari, majority of the cases (79.4%) were pneumonia, only 19.6% had severe pneumonia and there was one case of very severe illness. On the contrary, the number of cases with severe pneumonia was almost same as cases of pneumonia in Kathputly Colony and there was a significant number which were categorized as very severe illness by the health workers.

Majority of the children were treated with cotrimoxazole in both areas. About. 10-15% children in various groups were given alternative drugs like amoxycillin and cephalosphorins. Parents were reluctant to take their children to hospital so in most of the situations even children with severe illness continued to take treatment from the project doctor only. There were three deaths due to ALRI one each in wood users at Kusumpur Pahari and Kathputly Colony and one in kerosene users at Kusumpur Pahari.

Dropout rate

Mortality

Five children died in Kusumpur Pahari during this period. One death occurred due to ALRI, two deaths occurred due to diarrhoea and one child died because of convulsive disorder. Three deaths occurred in the first week of the study. One death occurred in third week and the other index child died in the eighth week.

Two deaths occurred in Kathputly Colony due to LRTI in the sixth week and the other child died for unknown reason.

Lost to follow up

During the study period, five children moved out permanently from the Kusumpur Area. Of these, three belonged to wood group and two to the kerosene group. Two of these were lost to follow up in the first week and one each in third, eighth and ninth week.

In Kathputly Colony, total of 18 children moved out, six belonged to kerosene group and 12 belonged to wood. Ten children were lost to follow up in third week, three in fourth week, two each in sixth and eighth week and one in tenth study week.

Follow up completed

Ninety four and 95% children completed the study in Kusumpur Pahari and kathputly Colony, respectively.

Follow-up extended two weeks for 97% of the children. The extended case fatality ratio was obtained by dividing the number of deaths by the estimated annual episodes occurring in the surveyed population.

Concordance between doctor's diagnosis and health worker's diagnosis

Agreement between doctor's diagnosis and health worker's diagnosis exceeded 95% and 99% in Kusumpur Pahari and Kathputly Colony, respectively.

Discussion

The aim of the present study was to find out the incidence of ALRI in two slums of Delhi and also to assess the relationship between indoor pollution and ALRI. There are about 1000 J.J. clusters (slums) in Delhi. These clusters consist of migrant population from various states of India. The population residing in these areas belongs to generally a poor socio-economic strata. The living conditions in these clusters are uniformly bad. Most of the families live in one room tenements (Jhuggi) clustered around small open courtyards. Sanitary conditions in these areas were poor. The water used for drinking and cooking was usually taken from shallow hand pumps.This had a very high rise of contamination due to inadequate number of sanitary latrines. Majority of the inhabitants had no regular source of income. However, in Kathputly Colony, there was a group of people who were artists by professional and had a relatively higher income. Kusumpur Pahari is situated in the south-west zone and is relatively less polluted area because the nearest industrial complex is about 10 km away and vehicular pollution around this area is minimal, whereas, Kathputly Colony is situated in the west zone of Delhi, very close to an industrial area and is exposed to lot of vehicular pollution because of proximity to major roads. Inhabitants of these areas used either wood or kerosene stoves for cooking purposes.

To the best of our knowledge, limited data on ALRI is available from underprivileged sections of the cities of India or elsewhere in the world. A total of 633 infants (316 infants in Kathputly Colony and 317 infants in Kusumpur Pahari) less than one year of age at the time of enrollment were followed-up for a period of 14 weeks to find out the incidence of ALRI amongst wood and kerosene user families. While in majority of literature available, studies on ALRI were conducted over a period of at least one year, in our study was restricted to peak winter season for ALRI. The overall incidence of ALRI in this study was found to be one episode per one child weeks at risk. Whereas incidence rates from the BOSTID studies ranged from 0.2 to 8.1 new episodes of ARI per 100 child weeks at risk (Selwyn, 1990). This variation in the incidence rate could be because of variability in definitions used for diagnosing ALRI. List of signs designed by BOSTID for ALRI were one of the following: respiratory rate > 50 per minute, rales, stridor, wheezing, convulsions or chest in drawing. The data from ARI in children 0-59 months of age from ten countries was synthesized by Board on Science and Technology for International Development (BOSTID). At all sites trained field workers and study physicians collected the data from either community or hospital which included outpatients as well as inpatients by once weekly visits with follow-up of full calendar year of 1986. However, in the present study we followed a WHO criteria for defining cases (i.e. no pneumonia, pneumonia, severe pneumonia and very severe illness). The first line of ascertainment in the present study was twice weekly home visits by trained field workers, who recorded signs and symptoms of ALRI. All cases of ALRI or suspected cases were referred to special study clinics where study physicians differentiated cases of ALRI from cases of AURI.

Age and sex distribution of cases and controls (Tables 1 and 2) amongst wood and kerosene users in both Kusumpur Pahari and Kathputly Colony were uniform and there was no statistically significant difference. The incidence of ALRI amongst wood users was 84 while it was 105 in kerosene users. However, only in Kathputly Colony it was statistically significant ($P_1 < 0.009$, Table 5). The demographic data of wood and kerosene families was comparable (Table 5), except that more primary educated mothers were found amongst kerosene users in both areas ($P < 0.000$). More self-employed mothers were found to be using kerosene in Kathputly Colony ($P < 0.000$). The family size and number of siblings in these areas were comparable in both the groups. Number of malnourished children was equal in all the groups, however, when malnutrition was graded, more severely malnourished infants were found in wood user families in Kusumpur Pahari. The immunization status of children was also found to be similar in all the groups except higher proportion of un immunized children amongst wood user families of Kathputly Colony. No explanation can be offered for differences observed between these groups.

Risk factors namely parental education, occupation, number of siblings, family size, nutritional and immunization status (Tables 3, 4, 6 and 7) were again comparable between cases and controls. There was no significant differences. Though maternal age was not known accurately but the impression was that they were young mothers as > 50% in both study areas already had more than two children. But in majority of the families, gap between index child and the older sibling appears to be more than two years.

Risk factors viz. young maternal age and less educated mothers were not consistently associated with higher incidence rates in our study as also reported by BOSTID studies (Selwyn, 1990). We did not observe any significant difference between nutritional status of cases and controls. Therefore, our findings concur with BOSTID researchers i.e. the impact of a low weight for age measure appears to be most important among children > 18 months of age (Selwyn, 1990).

Impact of other risk factors viz. sharing of sleeping rooms and smoking in the household is discussed in the other section of the report.

Though demographic data and other risk factors were comparable there was marked difference in number of cases of ALRI in Kusumpur Pahari (172) and Kathputly Colony (78). There was no statistically significant difference in Kusumpur Pahari between wood and kerosene user families but in Kathputly Colony this difference was statistically highly significant. No definite explanation can be offered for these findings. The higher incidence of ALRI in kerosene may be attributed to the thoroughness of the field workers and doctor responsible for the follow-up of the identified cases. In further analysis of duration of illness revealed longer duration of illness in Kusumpur Pahari. The illness of long duration may actually be sequential infection along with poor compliance with no or shorter intervening asymptomatic period.

Although the study populations, appear similarly poverty stricken there are variations in the incidence rates with in those studied, and the reasons for the difference need further elucidation. More work on the risk factors such as behavior, habits and conditions that enhance transmission of agents of the susceptibility of the child.Further more, the duration of illness and percentage of time will need analysis for a associated risk factor.

To best of our knowledge, no other study has done analysis according to number of episodes of ALRI each child suffered during the period of observation. Almost equal number of cases of ALRI were ascertained by health workers and doctors in their twice weekly visits to their homes. All the children diagnosed as ALRI were given a specific diagnosis by the doctor based on clinical definition of each (Table 10).

Majority of the cases were diagnosed as pneumonia in both the groups and study areas. The percentage of bronchiolitis varied from 12 to 27%. There was only one case of croup. About 1 to 5% of the cases of bronchial asthma were included as ALRI by health workers since diagnosis was based on WHO criteria.

Severity of illness was graded according to WHO criteria based on the information gathered by the workers and examination made by doctors. The number of cases of severe pneumonia varied from 18.1% to 40% in different groups. There appears to be suggestive bias in assessing the severity of illness because a much higher number of severe pneumonia and very severe illness was reported from Kathputly Colony. This bias could have arisen from interpretation of findings like refusal of feeds and lethargy etc. Secondly, better compliance and child rearing practices could have been responsible for their findings. Moreover, analysis of nutritional status was done on the completion of the study. This factor has not been used at all to label children with severe malnutrition as very severe illness. Had this factor been used a much higher number of cases could have been labelled as very severe illness in Kusumpur Pahari (wood user families). Interestingly, all these cases were treated with oral Cotrimoxazole and apparently responded to the treatment given at community. We did not use Chloramphenicol or injectable antibiotics at all. Majority of the patients even when referred to hospital, refused to go and preferred to take domiciliary treatment.

Fortunately, there were only two deaths related to ALRI, one in each study area. The Cotrimoxazole therapy even in severe pneumonia and very severe illness was found to be effective contrary to the recommendations in the WHO guidelines for ARI case management.

Although the study population appear uniformly poverty stricken, there are variations in the incidence rates within those studied, and the reasons for the differences need further elucidation. More work on risk factors such as behavior, habits and conditions that enhance transmission of agents or the susceptibility of the child. Furthermore, the duration of illness and percentage of time ill need analysis for associated risk factors.

Prevention and/or minimization of ALRI during infancy may be accomplished partially by promoting maternal education and by improving socio-economic development, all of which lead to better nutritional and health status. Strategies for estimation of contaminants include changes in domestic practices and habit, informing the parents about the symptoms, indicating the severity of illness, rapid treatment at a health center might be of considerable importance in this context.

Table 1. Age and sex distribution of the index children in Kusumpur Pahari

Index child	Wood users			Kerosene users		
	Control (n = 64)	Cases (n = 78)	Total (n = 142)	Control (n = 81)	Cases (n = 94)	Total (n = 175)
Age						
1 to 8 weeks	15 (23.4)	14 (17.9)	29 (20.4)	13 (16.0)	17 (20.2)	30 (17.1)
9 weeks to 1 year	49 (76.6)	64 (82.1)	113 (79.6)	68 (84.0)	77 (79.8)	145 (82.9)
Sex						
Male	29 (45.3)	45 (57.7)	74 (52.1)	47 (58.0)	45 (47.9)	92 (52.6)
Female	35 (54.7)	33 (42.3)	68 (47.9)	34 (42.0)	49 (52.1)	83 (47.4)

Note Figures in parenthesis represent in percentages.

Table 2. Age and sex distribution of the index children in Kathputly Colony

Index child	Wood users			Kerosene users		
	Control (n = 141)	Cases (n = 33)	Total (n = 174)	Control (n = 97)	Cases (n = 45)	Total (n = 142)
Age						
1 to 8 weeks	24 (16.7)	7 (21.2)	31 (17.8)	14 (14.4)	10 (22.2)	24 (16.9)
9 weeks to 1 year	117 (83)	26 (78.8)	143 (82.2)	83 (85.6)	35 (77.8)	118 (83.1)
Sex						
Male	66 (46.8)	11 (33.3)	77 (44.2)	44 (45.4)	20 (44.4)	64 (45.1)
Female	75 (53.2)	22 (66.7)	97 (55.8)	53 (54.6)	25 (55.6)	78 (54.9)

Note Figures in parenthesis represent in percentages.

Table 3. Comparison of demographic data of healthy control infants and cases with ALRI in wood and kerosene users in Kusumpur Pahari

	Wood				Kerosene			
	Control (n=64)	Cases (n=78)	Total (n=142)	P value	Control (n=81)	Cases (n=94)	Total (n=175)	P value
Father's education								
Illiterate	34 (53.1)	36 (46.2)	70 (49.3)	NS	32 (39.5)	31 (33.9)	63 (36)	NS
Primary	1 (1.5)	6 (7.7)	7 (4.9)		1 (1.2)	2 (2.1)	3 (1.7)	
Middle	19 (29.7)	18 (23.1)	37 (26.1)		26 (32.1)	37 (39.4)	63 (36)	
Secondary	10 (15.6)	16 (20.5)	26 (18.3)		20 (25.7)	21 (22.3)	41 (23 4)	
Higher	-	2 (2.5)	2 (1.4)		2 (2.5)	2 (2.1)	4 (2 3)	
Secondary	•	•	•		•	1 (1)	1 (0.6)	
Graduate								
Mother's education								
Illiterate	57 (89)	68 (87.2)	125 (88)	NS	60 (74.1)	70 (74.5)	130 (74.3)	NS
Primary	7 911)	10 (12.8)	17 (12)		21 (25.9)	24 (25.5)	45 (25.7)	
Father's occupation								
Wage laborer	22 (34.4)	19 (24.3)	41 (28.9)	NS	19 (23.5)	21 (22.3)	40 (22.9)	NS
Self employed	41 (64.1)	58 (74.4)	99 (69.7)		62 (76.5)	73 (77.7)	135 (77.1)	
Unemployed	1 (1.6)	1 (1.3)	2 (1.4)					
Mother's occupation								
Housewife	50 (78.1)	59 (75.6)	109 (76.8)	NS	62 (76.5)	84 (89.4)	146 (83 4)	0.02
Self employed	14 (21.9)	19 (24.4)	33 (23.2)		19 (23.5)	10 (10.6)	29 (16.6)	
Family size								
1-4 members	30 (47)	28 (35.9)	58 (40.8)	NS	47 (58)	49 (52)	96 (54 9)	NS
> 4 members	34 (53)	50 (64.1)	84 (59.2)		34 (42)	45 (48)	79 (45.1)	
Siblings								
≤ 2 years	9	13	22	NS	10	14	24	NS
> 3 years	109	156	265		110	145	255	

Note Figures in parenthesis denote percentages.

NS - Not significant.

Table 4. Comparison of demographic data of controls and cases in wood and kerosene users in Kathputly Colony

	Wood users				Kerosene users			
	Control (n=141)	Cases (n=33)	Total (n=174)	P value	Control (n=97)	Cases (n=45)	Total (n=142)	P value
Father's education								
Illiterate	86 (61)	21 (63.6)	107 (61.5)	NS	65 (67)	22 (48.9)	87 (61.3)	NS
Primary	10 (7.1)	3 (9.1)	13 (7.5)		7 (7.2)	8 (17.8)	15 (10.6)	
Middle	38 (26.9)	7 (21.2)	45 (25.8)		20 (20.6)	11 (24.4)	31 (21.8)	
Secondary	7 (5)	2 (6.1)	9 (5.2)		5 (5.2)	4 (8.9)	9 (6.3)	
Higher Secondary	-	-	-		-	-	-	
Graduate	-	-	-		-	-	-	
Mother's education								
Illiterate	138 (97.9)	30 (90.9)	168 (96.6)	0.04	83 (85.6)	40 (88.9)	123 (86.6)	NS
Primary	3 (2.1)	3 (9.1)	6 (3.4)		14 (1.4)	5 (11.1)	19 (13.4)	
Father's occupation								
Wage laborer	9 (6.4)	3 (9.1)	12 (6.9)	NS	85 (87.6)	30 (66.7)	115 (81)	0.00
Self employed	132 (93.6)	30 (90.9)	162 (93.1)		10 (10.3)	14 (31.1)	24 (16.9)	8
Unemployed	-				2 (2.1)	1 (2.2)	3 (2.1)	
Mother's occupation								
Housewife	131 (92.9)	30 (90.9)	161 (92.5)	NS	70 (72.2)	33 (73.3)	103 (72.5)	NS
Self employed	10 (7.1)	3 (9.1)	13 (7.5)		27 (27.8)	12 (26.7)	39 (27.5)	
Family size								
1-4 members	51 (36.2)	14 (42.4)	65 (37.4)	NS	41 (42.3)	15 (33.3)	56 (39.4)	NS
> 4 members	90 (63.8)	19 (57.6)	109 (62.6)		56 (57.7)	30 (66.7)	86 (60.6)	
Siblings								
≤ 2 years	19	9	28	NS	14	3	17	NS
> 3 years	294	63	357		179	94	173	

Note Figures in parenthesis denote percentages.

NS - Not significant.

Table 5. Comparison of demographic data of wood and kerosene users in both Kusumpur Pahari and Kathputly Colony

	Kusumpur Pahari			Kathputly Colony		
	Wood (n=142)	Kerosene (n=175)	P value	Wood (n=174)	Kerosene (n=142)	P value
Number of healthy control	64 (45.1)	81 (46.3)	NS	141 (81)	97 (68.3)	0 009
Number of cases with LRTI	78 (54.9)	94 (53.7)		33 (19)	45 (31.7)	
Father's education						
Illiterate	70 (49.3)	63 (36)	NS	107 (61.5)	87 (61.3)	NS
Primary	7 (4.9)	3 (1.7)		13 (7.5)	15 (10.6)	
Middle	37 (26.1)	63 (36)		45 (25.9)	31 (21.8)	
Secondary	26 (18.3)	41 (23.4)		9 (5.1)	9 (6.3)	
Higher Secondary	2 (1.4)	4 (2.3)		-	-	•
Graduate	-	1 (0.6)		-	-	
Mother's education						
Illiterate	125 (88)	130 (74.3)	0.00	168 (96.6)	123 (86.6)	0.001
Primary	17 (12)	45 (25.7)	2	6 (3.4)	19 (13 4)	
Father's occupation						
Wage laborer	99 (69.7)	135 (77.1)	NS	162 (93.1)	115 (81)	0 002
Self employed	41 (28.9)	40 (22.9)		12 (6.9)	24 (16.9)	
Unemployed	2 (1.4)	-		-	3 (2.1)	
Mother's occupation						
Housewife	109 (76.8)	146 (83.4)	NS	161 (92.5)	103 (72.5)	0 000
Self employed	33 (23.2)	29 (16.6)		13 (7.6)	39 (7.5)	
Family size						
1-4 members	58 (40.8)	96 (54.9)	0.04	65 (37.4)	56 (39.4)	NS
> 4 members	84 (59.1)	79 (45.1)		109 (62.6)	86 (60.6)	
Siblings						
≤ 2 years	22	24	NS	28	19	NS
> 3 years	265	255		357	273	

Note Figures in parenthesis denote percentages.

NS - Not significant

Nutritional status according to Gomez's classification

Normal - > 90% of the

Mild - 90 - 76% of the normal weight for age.

Moderate - 75 - 60% of the normal weight for age.

Severe - < 60% of the normal weight for age.

Table 6. Comparison of nutritional and immunization status of controls and cases in Kusumpur Pahari

	Wood user				Kerosene user			
	Control (n = 64)	Cases (n = 78)	Total (n = 142)	P value	Control (n = 81)	Cases (n = 94)	Total (n = 195)	P value
Nutritional status								
Normal	25 (41)	29 (39.2)	54 (38)	NS	32 (41)	38 (42.2)	70 (40.0)	NS
Mild malnutrition	11 (18)	14 (18.9)	25 (17.6)		25 (32)	29 (32.2)	54 (30.9)	
Moderate malnutrition	8 (8)	13 (17.6)	21 (14 8)		9 (11.5)	17 (18.9)	26 (14.9)	
Severe malnutrition	17 (27.9)	18 (24.3)	35 (24 6)		12 (15.9)	6 (6.7)	18 (10 3)	
Immunization status								
Not immunized	22 (34.4)	19 (24.4)	41 (28.8)	NS	20 (24.7)	26 (27.7)	46 (26.3)	NS
Partially immunized	24 (37.5)	39 (50)	63 (44.4)		32 (39.5)	32 (34.0)	64 (36 6)	
Completely immunized	18 (28.1)	20 (25.6)	38 (26.8)		29 (35.8)	36 (38.3)	65 (37 1)	
Measles ≥ 36 weeks								
Infants eligible	24 (37.5)	28 (35.9)	52 (36 6)	NS	35 (45.5)	42 (54.5)	77 (44 00	NS
Yes	12 (50)	12 (42.9)	24 (46.1)		18 (51.4)	22 (52.4)	40 (51.9)	
No	12 (50)	16 (57.1)	28 (53.8)		17 (48.6)	20 (47 6)	37 (48 1)	

Note Figures in parenthesis denote percentages.
NS - Not significant

Nutritional status according to Gomez's classification
Normal - > 90% of the normal weight for age.
Malnutrition
Mild - 90-76% of the normal weight for age.
Moderate - 75-60% of the normal weight for age.
Severe - < 60% of the normal weight for age.

Table 7. Comparison of nutritional and immunization status of case infants with ALRI and healthy control infant in Kathputly Colony

	Wood users				Kerosene users			
	Control (n=141)	Cases (n=33)	Total (n=174)	P value	Control (n=97)	Cases (n=45)	Total (n=142)	P value
Nutritional Status								
Normal	38 (31.9)	11 (34.4)	49 (28.1)	NS	28 (30.4)	20 (44 4)	48 (33.8)	NS
Mild malnutrition	47 (39.5)	10 (31.3)	57 (32.8)			17 (37 8)	55 (38 7)	
Moderate malnutrition	28 (23.5)	8 (25.0)	36 (20.7)		38 (41.3)	7 (15 6)	28 (19.7)	
Severe malnutrition	6 (5.0)	3 (9.4)	9 (5.2)			1 (2 2)	6 (4 2)	
Missing	22 (15.6)	1 (3)	23 (13.2)		21 (22.8)	-	5 (3.5)	
					5 (5.4)			
					5 (5.4)			
Immunization status								
Not immunized	60 (42.6)	13 (39.4)	73 (42)	NS	23 (23.7)	18 (40 0)	41 (28.9)	NS
Partially immunized	45 (37.9)	15 (45.5)	60 (34.5)			13 (28 9)	51 (35.9)	
Completely immunized	36 (25.5)	5 (15.2)	41 (23.5)		38 (39.2)	14 (31 1)	50 (35 2)	
					36 (37.1)			
Measles ≥ 36 weeks								NS
Infants eligible	82 (58.1)	12 (36.4)	94 (54)	NS	58 (59.8)	15 (33.3)	73 (51.4)	
Yes	22 (26.8)	2 (16.7)	24 (25.5)			4 (26 7)	20 (27.4)	
No	58 (70.7)	10 (83.3)	68 (72.3)		16 (27.6)	11 (73 3)	53 (72.6)	
					42 (72.4)			
Missing	2 (2.4)		2 92.12)					

Note Figures in parenthesis denote percentages.

NS - Not significant

Nutritional status according to Gomez's classification

Normal - > 90% of the normal weight for age.

Malnutrition

Mild - 90-76% of the normal weight for age.
Moderate - 75-60% of the normal weight for age.
Severe - < 60% of the normal weight for age.

Table 8. Comparison of nutritional and immunization status including measles between two group (wood and kerosene) in both study areas

	Kusumpur Pahari			Kathputly Colony		
	Wood (n=142)	Kerosene (n=175)	P value	Wood (n=174)	Kerosene (n=142)	P value
Nutritional Status						
Normal	54 (40)	70 (41.7)	0.00	49 (32.5)	48 (35)	NS
Mild malnutrition	25 (18.5)	54 (32.1)	6	57 (37.7)	55 (40.1)	
Moderate malnutrition	21 (15.6)	26 (15.5)		36 (23.8)	28 (20.4)	
Severe malnutrition	35 (25.8)	18 (10.7)		9 (6.0)	6 (4.4)	
Missing	7 (5.9)	7 (4)		23 (13.2)	5 (3.5)	
Immunization status						
Not immunized	41 (28.9)	46 (26.3)	NS	73 (42)	41 (28.9)	0.02
Partially immunized	63 (44.4)	64 (36.6)		60 (34.5)	51 (35.9)	
Completely immunized	38 (26.8)	65 (37.1)		41 (23.5)	50 (35.2)	
Measles ≥ 36 weeks						
Infants eligible	52 (40.3)	77 (59.7)	NS	94 (54.0)	73 (43.7)	NS
Yes	24 (46.2)	40 (51.9)		24 (25.5)	20 (27.4)	
No	28 (53.8)	37 (48.1)		68 (72.3)	53 (72.6)	
Missing				2 (2.1)		

Note Figures in parenthesis denote percentages.

NS - Not significant.

Table 9. Distribution of number of episodes of ALRI in Kusumpur Pahari and Kathputly Colony

	Kusumpur Pahari		Kathputly Colony	
	Wood	Kerosene	Wood	Kerosene
Total number of infants	142	175	174	142
Number of children with ALRI	78 (54)	94 (53)	33 (18.9)	45 (31)
Number of children with one episode	57 (73)	73 (76.7)	27 (81.8)	32 (71.1)
Number of children with two episodes	18 (23)	20 (15.2)	5 (15.2)	12 (26.7)
Number of children with three episodes	3 (4)	1 (1.1)	1 (3.0)	1 (2.2)
Total number of episodes of ALRI	102	116	40	59

Table 10. Specific diagnosis in infants suffering from Lower Respiratory Tract Infection (ALRI)

Doctor's diagnosis	Kusumpur Pahari		Kathputly Colony	
	Wood (n=102)	Kerosene (n=116)	Wood (n=40)	Kerosene (n=59)
Pneumonia	82 (80.5)	98 (84.5)	30 (75)	42 (71.2)
Bronchiolitis	14 (13.7)	14 (12.1)	9 (22.5)	16 (27.1)
Croup	1 (1.0)	-	-	-
Bronchial Asthma	5 (4.9)	4 (3.4)	-	1 (1.7)
Others	-	-	1 (2.5)	-

Note Figures in parenthesis denote percentages.

Table 11. Severity of illness in cases in Kusumpur Pahari and Kathputly Colony

Severity of illness	Kusumpur Pahari		Kathputly Colony	
	Wood (n=102)	Kerosene (n=116)	Wood (n=40)	Kerosene (n=59)
Pneumonia	81 (79.4)	94 (81.0)	17 (42.5)	11 (18.6)
Severe Pneumonia	20 (19.6)	21 (18.1)	16 (40)	21 (35.6)
Very severe illness	1 (1.0)	-	7 (17.5)	27 (45.8)

Note Figures in parenthesis denote percentages.

Table 12. Duration of illness in infants suffering from ALRI

Duration of illness	Kusumpur Pahari		Kathputly Colony	
	Wood (n=102)	Kerosene (n=116)	Wood (n=40)	Kerosene (n=59)
Less than 7 days	45 (44.1)	45 (38.8)	35 (87.0)	46 (78)
7-14 days	13 (12.7)	15 (12.9)	5 (12.5)	10 (16.9)
More than 15 days	44 (43.1)	56 (48.3)		3 (5.1)

Note Figures in parenthesis denote percentages.

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Annexure 1

Form Number - 1
(Children below one year)

Slum code:	Fuel code:	Serial Number:
Child's name:	Age: (Months)	Sex: Male/Female
Father's name:		
Age:	Education:	Occupation:
Mother's name:		
Age:	Education:	Occupation:
Family size:		

The remaining children:	Age	Sex: Male/Female
1.		
2.		
3.		
4.		
5.		
6.		

Vaccination:

BCG	Yes/No		
D.P.T/Polio	1	2	3
Diphtheria	Yes/No		
Measles	Yes/No		
Status of vaccination:	1. Complete	2. Partial	3. Not at all

Detail of the breast feeding:

At what age the child is breast exclusive breast feeding...........months.

At what age the breast feed discontinued for the child..........months.

Weight of the child..........grams.

The infant's weight:

S.No.	Date	Study week	Grams
1.			
2.			
3.			
4.			

The infants previous medical history:

Cough:	Yes/No
Cough and fever:	Yes/No
Subcostal recession:	Yes/No

Annexure 2

Form Number - 2
(Follow up form)

Date:
Slum code:
Serial number:

Complaints of:

Cough:	Yes/No	........days.
Fever:	Yes/No	........days.
Runny nose:	Yes/No	........days.
Rapid respiratory rate:	Yes/No	........days.
Ear discharge:	Yes/No	........days.

If yes, do the infant has other symptoms:

Appetite:	Yes/No
Lethargic:	Yes/No
Excessive crying:	Yes/No
Peevish:	Yes/No
Wheeze:	Yes/No
Breathlessness:	Yes/No
Periods of apnoea:	Yes/No
Unconscious:	Yes/No
Convulsions:	Yes/No
Treatment:	Yes/No

If yes, where from:

1. Doctor
2. Quack
3. Dispensary
4. Hospital
5. Nursing home
6. Home remedies
7. Others

On examination:

Fever: Yes/No

Nose blockage: Yes/No

Ear discharge: Yes/No

Respiratory rate per minute.

Intercostal recession: Yes/No

Wheezing: Yes/No

Stridor: Yes/No

Able to drink milk: Yes/No

Is the infant still breast fed: Yes/No

Health worker's diagnosis: URTI/LRTI

Doctor's Diagnosis:

Annexure 3

Tata Energy Research Institute
(Daily Chart)

Date:
Serial number:
Health worker's name:
Slum code:

If the infant suffers from acute lower respiratory infection (ALRI), kindly mark it with red pen in the given square. Continue to do so till the child is symptom free.

Annexure 4

1. Slum code:
    - 1 Low pollution
    - 2 High pollution
2. Fuel code:
    - 1 Wood user
    - 2 Kerosene user
3. Serial number:
4. Mother's age (years) :
5. Father's age (years) :
6. Father's education:
    - 0 Illiterate
    - 1 Primary
    - 2 Middle
    - 3 Secondary
    - 4 Higher Secondary
    - 5 Graduate
    - 6 Post Graduate
    - 9 Missing
7. Mother's education:
    - 0 Illiterate
    - 1 Primary
    - 2 Middle
    - 3 Secondary
    - 4 Higher Secondary
    - 5 Graduate
    - 6 Post Graduate
    - 9 Missing
8. Mother's occupation:
    - 1 Housewife
    - 2 Domestic servant
    - 3 Wage labourer
    - 4 Self employed
    - 5 Service
    - 9 Missing
9. Father's occupation:
    - 1 Domestic servant
    - 2 Wage labourer
    - 3 Self employed
    - 4 Service
    - 5 Unemployed
    - 9 Missing
10. Family size:

11.	Sibling age (years)	Sex (1 Male, 2 Female)
i)		
ii)		
iii)		
iv)		
v)		
vi)		
vii)		

12. Age of the index child:

13. Sex:
1 Male 2 Female
14. Immunization
BCG (Scar testing) :
1 Yes 2 No 9 Missing
DPT:
0 No dose 1 First dose 2 Second dose
3 Third dose 9 Missing
OPV:
0 No dose 1 First dose 2 Second dose
3 Third dose 9 Missing
Measles:
1 Yes 2 No 9 Missing
15. Immunization status:
0 Not immunized 1 Partially immunized 2 Completely immunized
16. Exclusive breast feeding till the age (months) :
17. Breast feeding discontinued at age (months) :
88 Still continuing 99 Missing
18. Weight (gms)

	Date	Study week	Weight (in grams)
1.			
2.			
3.			

9999 Missing
19. Past history of fast breathing:
1 Yes 2 No 9 Missing
20. Is previous history suggestive of bronchial asthma:
1 Yes 2 No 9 Missing
21. Number of episodes diagnosed by the health worker:
22. Number of episodes diagnosed by the Doctor:

23. Description of each LRTI episode diagnosed by the Doctor:

No.	Date	Study week	Duration (days)	Treatment given	Outcome	Worker's diagnosis	Doctor's diagnosis	Severity of illness
1.								
2.								
3.								
4.								

Treatment given:

1 Cotrimoxazole (Trimethoprim 8 mg/kg/d + Sulphamethoxazole 40 mg/kg/d) 12-hourly
2 Amoxycillin 50 mg/Kg/d 8 hourly
3 Others

Codes for outcome:

1 Treated successfully
2 Referred to hospital
3 Poor compliance
4 Treatment refused
5 Death

Doctor's diagnosis:

1 Pneumonia
2 Bronchiolitis
3 Croup
4 Bronchial asthma
4 Other respiratory disorders

Worker's diagnosis:

1 LRTI
2 URTI

Severity of illness:

1 Pneumonia
2 Severe pneumonia
3 Very severe illness

24. Presence of associated illnesses:

1 Congenital heart disease
2 Acute suppurative otitis media
3 Chronic suppurative otitis media
4 Diarrhoea
5 Others
6 None

25. Lost to follow up:

	Reason	Date	Study week
1.	No		
2.	Death		
3.	Moved out		

26. If the child died - reason:

1 LRTI
2 Diarrhoea
3 Convulsive disorder
4 Any other